RECENT PAPERS BEARING ON METEOROLOGY.

H. H. Kimball, Librarian.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a ——

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Daingerfield, Lawrence H. The evolution of climate. p. 641–643.

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Keeling, B. F. E. Upper air research in Egypt. p. 637.
Bonacina, L. C. W. Rain gage exposure and protection. p. 672–673.

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Rawson, H. E. Anticyclones as aids to long-distance forecasts. p. 309–310.

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NOTE ON THE DIURNAL HEAT EXCHANGE IN A LAYER OF SNOW ON THE GROUND.

By T. Okada.

[Reprinted from the Journal of the Meteorological Society of Japan, April, 1907.]

The earth accumulates solar heat during the daytime, and gradually loses the stored energy during the nighttime, so that there is a diurnal heat exchange in the upper layers of the earth's crust. The determination of the amount of this heat exchange in different kinds of soil is one of the interesting problems of meteorology. Already various memoirs on this subject have been published by several investigators. Among others, Dr. Theodor Homén, of the University of Helsingfors, made several researches on the heat contents of such soils as humus, sand, and clay, and published the result of his discussion in his excellent treatise on the diurnal heat exchange in soil. Recently Prof. J. Schubert, of the Eberswalde Dendrological College, took up the subject, and completed Homén's investigation both in theory and observation, so that little remains for further researches.

In winter when snow covers the ground 1 or 2 meters deep, the daily heat exchange takes place in the upper layers of the snow, and the variations of heat content cease to be appreciable at a depth of a few decimeters. This exchange of heat in the outer layers of the accumulated snow plays an important rôle in producing the diurnal variations of temperature in the lower part of the atmosphere. It is, therefore, of some interest to determine the amount of the daily variations of heat content in snow on the ground. The following discussion is based upon the observations of temperature at different depths under the surface of the snow taken at the Kamikawa Meteorological Observatory, in Hokkaido.[1]

The observations were made every hour during eight days from the 16th to the 23d of February, 1907, in the compound of the observatory. The temperature was observed by long-stem mercurial thermometers inserted vertically to the specified depths, and projecting a few centimeters above the surface. The following table contains the results of the observations:

TABLE I.—*Mean temperature (centigrade) for the eight days from February 16 to 23, 1907, at various depths under surface of snow.*

Hour.	Depth in centimeters.				
	0	5	10	20	30
	°	°	°	°	°
1 a. m	—20.91	—17.06	—12.46	—7.92	—5.91
2 a. m	—21.65	—17.80	—12.96	—8.11	—5.97
3 a. m	—22.40	—18.37	—13.47	—8.32	—6.06
4 a. m	—22.65	—18.80	—13.92	—8.51	—6.09
5 a. m	—22.64	—19.07	—14.36	—8.75	—6.12
6 a. m	—22.40	—19.14	—14.71	—8.95	—6.24
7 a. m	—21.67	—18.90	—14.86	—9.10	—6.27
8 a. m	—18.84	—17.42	—14.76	—9.24	—6.31
9 a. m	—13.65	—14.29	—14.09	—9.27	—6.37
10 a. m	— 9.81	—10.77	—12.91	—9.34	—6.41
11 a. m	— 6.09	— 8.12	—11.30	—9.26	—6.47
12 noon	— 4.45	— 7.06	— 9.97	—9.14	—6.49
1 p. m	— 3.77	— 5.70	— 8.76	—8.95	—6.50
2 p. m	— 3.82	— 5.22	— 7.77	—8.62	—6.51
3 p. m	— 6.19	— 5.77	— 7.34	—8.32	—6.51
4 p. m	— 8.64	— 7.60	— 7.37	—8.07	—6.51
5 p. m	—12.56	— 9.81	— 7.64	—7.92	—6.49
6 p. m	—14.91	—11.40	— 8.55	—7.72	—6.44
7 p. m	—15.66	—12.64	— 9.25	—7.66	—6.36
8 p. m	—16.40	—13.52	— 9.96	—7.61	—6.31
9 p. m	—17.49	—14.22	—10.55	—7.64	—6.21
10 p. m	—17.57	—14.66	—11.09	—7.75	—6.21
11 p. m	—17.79	—15.02	—11.51	—7.89	—6.21
12 midnight	—18.45	—15.49	—11.84	—8.04	—6.19
Mean	—15.02	—13.24	—11.31	—8.42	—6.30

Mr. J. Yamada of the observatory measured the specific density of snow at different depths, and obtained the following results as the mean of the three measurements:

	Depth in centimeters.					
	5	15	25	35	45	55
Density	0.159	0.240	0.267	0.306	0.361	0.380

According to von Bezold[2] the variation of the heat content of the soil per unit area is $\int_0^H C(\theta_2 - \theta_1)\,dh$, where H is the depth of invariable temperature, θ_1 and θ_2 are the temperatures at the depth of h corresponding to the times t_1 and t_2, and C is the heat capacity per unit volume.

[1] From the latest Annual Report, Central Meteorological Observatory of Japan, this observatory is located in latitude 43° 47′ N., longitude 142° 22′ E.; with altitude of barometer above sea level, 113.3 meters.—EDITOR.

[2] Von Bezold: Der Wärmeaustausch an der Erdoberfläche und in der Atmosphäre. 1892. Gesam. Abh. S. 344.

In making the integration an accurate knowledge of the density and specific heat of snow in the different layers is indispensable. By simple interpolations I have calculated the mean density of snow for the various strata, and obtained the heat capacity per unit volume by multiplying the mean density by 0.508, the specific heat of ice. The following table contains the results of my computations:

	Depth in centimeters.			
	0–5	5–10	10–20	20–30
Mean density	0.139	0.179	0.227	0.271
Heat capacity, gram-cal. per cm^3	0.0706	0.0909	0.1153	0.1376

Using the above values of heat capacity the integral has been evaluated. The following table contains the result of the summations:

TABLE II.—*Variation in gram-calories of heat content in snow on the ground.*

Time interval.	Depth in centimeters.				
	0–5	5–10	10–20	20–30	Total.
Midnight to 1 a. m	—0.71	—0.90	—0.29	+0.28	—1.71
1 to 2 a. m	—0.26	—0.56	—0.39	—0.17	—1.38
2 to 3 a. m	—0.24	—0.49	—0.41	—0.21	—1.35
3 to 4 a. m	—0.12	—0.40	—0.36	—0.15	—1.03
4 to 5 a. m	—0.05	—0.32	—0.39	—0.18	—0.94
5 to 6 a. m	+0.03	—0.19	—0.31	—0.22	—0.69
6 to 7 a. m	+0.17	+0.04	—0.17	—0.12	—0.08
7 to 8 a. m	+0.76	+0.12	—0.02	—0.12	+0.74
8 to 9 a. m	+1.47	+1.77	+0.36	—0.05	+3.51
9 to 10 a. m	+1.31	+2.14	+0.63	—0.07	+4.01
10 to 11 a. m	+1.13	+1.94	+0.97	+0.01	+4.05
11 a. m. to noon	+0.49	+1.08	+0.83	+0.07	+2.46
Noon to 1 p. m	+0.36	+1.16	+0.81	+0.12	+2.45
1 to 2 p. m	+0.06	+0.66	+0.76	+0.22	+1.70
2 to 3 p. m	—0.52	—0.05	+0.41	+0.21	+0.05
3 to 4 p. m	—0.76	—0.85	+0.13	+0.17	—1.31
4 to 5 p. m	—1.08	—1.13	—0.07	+0.11	—2.17
5 to 6 p. m	—0.70	—1.17	—0.40	+0.17	—2.07
6 to 7 p. m	—0.35	—0.88	—0.37	+0.10	—1.50
7 to 8 p. m	—0.29	—0.72	—0.38	+0.07	—1.32
8 to 9 p. m	—0.32	—0.58	—0.36	+0.04	—1.22
9 to 10 p. m	—0.09	—0.45	—0.37	—0.07	—0.98
10 to 11 p. m	—0.10	—0.35	—0.32	—0.10	—0.87
11 p. m. to midnight	—0.20	—0.36	—0.28	—0.08	—0.92

In the above calculation the summation does not extend to the depth of the invariable stratum. The results given above may therefore be considered as the variations of the heat contained in the stratum above the plane 30 centimeters deep. But as the variation of the temperature at the bottom of the stratum is only 0.6°, the amount of heat which flows in or out across the plane amounts only to a small percentage of the total exchange, and in a rough approximation may be left out of account.

The total daily heat exchange in the snow on the ground is 18.97, or, in round numbers, 19 gram-calories per square centimeter. For comparison we give below the amounts of the diurnal heat exchange in various kinds of soil calculated by Doctor Schubert:[3]

Kind of soil.	(a)	(b)	(c)
Moor soil, with growing conifers	15		
Sand soil, with growing conifers	21		24
Moor meadow	43	33	
Sand soil	80	65	62
Granite rocks		134	

The observations were taken (a) near Lake Lojo, in S. Finland, in August and September, 1892; (b) at the same place in August, September, and October, 1896; (c) at Eberswalde, in July, 1879.

From the above table it may be seen that the heat exchange in snow on the ground is rather large, and is quite comparable with that in soil covered with vegetation.

[3] J. Schubert: Der Wärmeaustausch im festem Erdboden, in Gewässern und in der Atmosphäre. Phys. Zeit. IIIte Band. S. 118.

When clouds cover the sky the greater part of the solar rays can not reach the earth's surface, and the nocturnal radiation of heat from the earth is also hindered. The effect of clouds is, therefore, to diminish the amount of the heat exchange in the upper layer of the earth's crust. In order to see what difference occurs in the heat exchange in the snow layers under consideration on clear and cloudy days I have computed the amounts of exchange in two selected days. As the clear day I have selected February 17, and as the cloudy day, February 23. The mean amount of cloud is 0.8 on the former day, and 9.7 on the latter day. On both days the diurnal temperature wave penetrated below the depth of 30 centimeters. The range of the temperature at this depth was 1.7° on the clear day, and 1.2° on the cloudy day. Hence, in calculating the variations of heat content the quantity of heat which flowed across the plane at 30 centimeters below the surface of the ground must be taken into account. But I have abstained from making such corrections in my computations, since the correction is certainly a small quantity, at most about 5 per cent of the total amount, and in such a discussion as the present one a knowledge of only the order of the required value is sufficient for my purpose. Strictly speaking, therefore, the result obtained below is to be regarded as the diurnal heat exchange taking place in the uppermost 30 centimeters of a deep layer of snow.

Table III contains the amount of the heat exchange on the clear day, and Table IV that on the cloudy day.

TABLE III.—*Heat exchange (gram-calories) in snow on clear day.*

Time interval.	Depth in centimeters.				
	0-5	5-10	10-20	20-30	Total.
Midnight to 1 a.m.	−0.30	−0.64	−0.63	−0.28	−1.85
1 to 2 a.m.	−0.35	−0.77	−0.58	−0.41	−2.11
2 to 3 a.m.	−0.10	−0.50	−0.52	−0.28	−1.40
3 to 4 a.m.	−0.21	−0.50	−0.58	−0.28	−1.57
4 to 5 a.m.	−0.17	−0.55	−0.52	−0.34	−1.58
5 to 6 a.m.	−0.21	−0.50	−0.46	−0.34	−1.51
6 to 7 a.m.	−0.05	−0.27	−0.29	−0.21	−0.82
7 to 8 a.m.	+1.09	+0.86	−0.23	−0.28	+1.44
8 to 9 a.m.	+1.66	+1.91	+0.40	0.00	+3.97
9 to 10 a.m.	+1.67	+2.73	+0.63	−0.28	+4.75
10 to 11 a.m.	+1.78	+2.64	+1.15	−0.14	+5.43
11 a.m. to noon	+0.60	+1.00	+0.69	0.00	+2.29
Noon to 1 p.m.	+0.47	+1.64	+1.09	+0.14	+3.34
1 to 2 p.m.	+0.37	+1.05	+0.86	0.00	+2.28
2 to 3 p.m.	−0.51	+0.41	+0.69	+0.21	+0.80
3 to 4 p.m.	−0.46	−0.41	+0.40	+0.21	−0.26
4 to 5 p.m.	−1.16	−1.14	−0.58	+0.14	−2.74
5 to 6 p.m.	−0.70	−1.14	−0.23	+0.21	−1.86
6 to 7 p.m.	−0.95	−1.23	−0.35	+0.07	−2.46
7 to 8 p.m.	−1.09	−1.64	−0.46	+0.14	−3.05
8 to 9 p.m.	−0.54	−1.18	−0.58	+0.14	−2.16
9 to 10 p.m.	−0.32	−1.09	−0.75	−0.14	−2.30
10 to 11 p.m.	−0.28	−0.59	−0.63	−0.28	−1.78
11 p.m. to midnight	−0.46	−0.82	−0.52	0.00	−1.80

TABLE IV.—*Heat exchange (gram-calories) in snow on cloudy day.*

Midnight to 1 a.m.	−0.12	−0.45	−0.35	+0.14	−0.78
1 to 2 a.m.	−0.02	−0.05	0.00	+0.07	0.00
2 to 3 a.m.	+0.14	+0.09	−0.06	0.00	+0.17
3 to 4 a.m.	+0.14	+0.14	0.00	0.00	+0.28
4 to 5 a.m.	+0.05	+0.27	+0.17	+0.07	+0.56
5 to 6 a.m.	0.00	−0.09	0.00	+0.14	+0.05
6 to 7 a.m.	+0.10	+0.18	+0.17	+0.07	+0.52
7 to 8 a.m.	+0.30	+0.36	+0.12	+0.21	+0.99
8 to 9 a.m.	+0.46	+0.77	+0.29	0.00	+1.52
9 to 10 a.m.	+0.65	+1.00	+0.46	+0.14	+2.25
10 to 11 a.m.	+0.40	+0.91	+0.63	+0.21	+2.15
11 a.m. to noon	+0.16	+0.68	+0.46	0.00	+1.30
Noon to 1 p.m.	+0.26	+0.50	+0.35	+0.14	+1.25
1 to 2 p.m.	−0.28	0.00	+0.40	+0.34	+0.46
2 to 3 p.m.	−0.63	−0.59	+0.06	+0.14	−1.02
3 to 4 p.m.	−0.60	−0.86	−0.17	+0.07	−1.56
4 to 5 p.m.	−0.62	−1.05	−0.36	+0.07	−1.96
5 to 6 p.m.	−0.26	−0.45	−0.17	+0.14	−0.74
6 to 7 p.m.	−0.16	−0.55	−0.29	+0.07	−0.93
7 to 8 p.m.	−0.19	−0.36	−0.23	+0.07	−0.71
8 to 9 p.m.	−0.10	−0.41	−0.29	−0.07	−0.87
9 to 10 p.m.	−0.21	−0.36	−0.35	−0.14	−1.06
10 to 11 p.m.	−0.23	−0.36	−0.12	0.00	−0.71
11 p.m. to midnight	−0.46	−0.64	−0.40	−0.14	−1.64

The total amount of the heat exchange is 24.3 gram-calories on the clear day, and 11.5 gram-calories on the cloudy day. The former is double the latter.

A BIOGRAPHICAL SKETCH OF PROF. DIRO KITAO.

By Dr. S. TETSU TAMURA, Professor of Meteorology and Ocean Physics, Naval Staff College.

[Extract from a memoir, printed in the Journal of the Meteorological Society of Japan, September, 1907.]

* * * Whatever the definition of human greatness may be, it can not be denied that all great men of science have made great and wonderful discoveries, and have inspired their pupils and followers to a nobler ambition, as contributors to the sum of human knowledge. Here in Japan we find an excellent example of such a man in Professor Doctor Kitao, the profound mathematician and original thinker, who has just past away from us (on September 7, 1907), but whose masterful work has left a lasting impression on the progress of theoretical meteorology and mathematical physics.

Prof. Diro Kitao was born in Matsue in the province of Izumo, on the fourth of July of the memorable year 1853 when Commodore Perry first visited Uraga. His father, who was a physician, was called Kwanyu Matsumura, and the early name of Professor Kitao was Rokujiro Matsumura. Young Rokujiro, or Diro, as he was called later, early developed a bent for serious study, and at such a youthful age as ten his rare gifts marked him out as a genius of great promise. It is said that, when yet so young, he already became a master of Chinese classics and history, and wrote several beautiful poems. The attention of Zenichiro Kitao, then a famous scholar of the Dutch language, was attracted by the precosity of the young boy, and finally the elder scholar adopted him and sent him to the schools in Tokyo and Osaka. After some preliminary training at both these places, Diro Kitao was, in 1870, sent by the government to Germany for study. He went thru the gymnasium at Berlin in 1873 and then entered the University of Berlin to study mathematical physics under Helmholtz. Later he was identified with Göttingen University, where in 1879 he wrote a remarkable inaugural dissertation, "Farbenlehre", and took the degree of doctor of philosophy with honors. Doctor Kitao continued his study in Germany for four more years, and it was in one of those years that he invented the Leukoskop and that he met the present Frau Louise Kitao and was married to her. After an absence of fourteen years he returned to his native land with his German wife. During his long stay in Europe Doctor Kitao experienced a great many pecuniary difficulties and even adversities; for tho for the first one or two years he was supported by the Japanese Government, later he had, owing to a change of our governmental system, to support himself by teaching mathematics to lower students or by writing for German magazines and newspapers. It is said that an American Consul to Germany, Mr. Mayer, was greatly interested in Doctor Kitao and assisted him in many useful ways. How hard it is for one to be in such circumstances in a strange country can scarcely be realized except by experience.

The result of his hard study and perseverance was made apparent when, on his return to Japan in 1884, Doctor Kitao was appointed lecturer and soon after promoted to the professorship of physics, in the Imperial University of Tokyo. It was still more apparent when, in 1886, he was appointed professor of physics in the Tokyo Agricultural School and, in 1888, professor of meteorology in the Naval Staff College, while retaining his older position in the Imperial University. In 1890 the Tokyo Agricultural School was made a part of the Imperial University as the Agricultural College, and Doctor Kitao became professor of forest physics and meteorology in the college. This last position he held till recently. In 1891 he received the honorary degree of doctor of science from the university.

The following is the record of his published papers:

1. Zur Farbenlehre.
(Eine Inaugural-dissertation. Berlin, 1879).